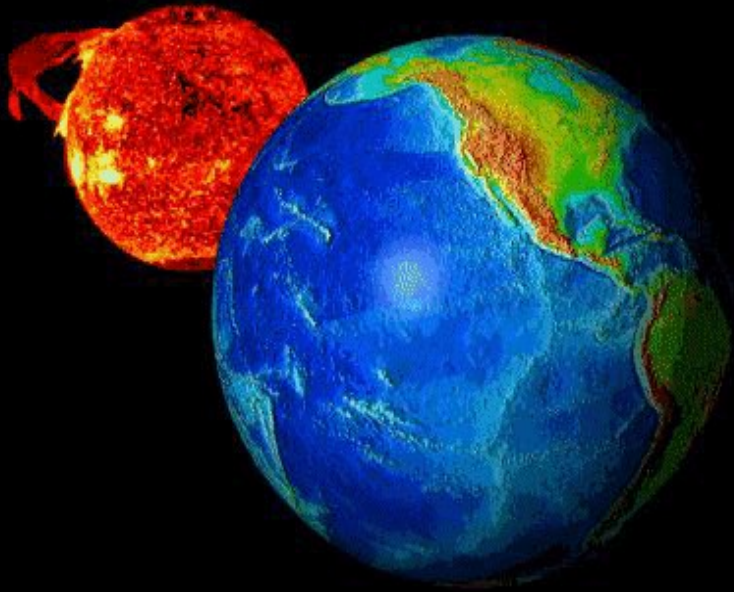


***HQ AFWA/XOGX
Space Weather Branch
Space Weather Tutorial***

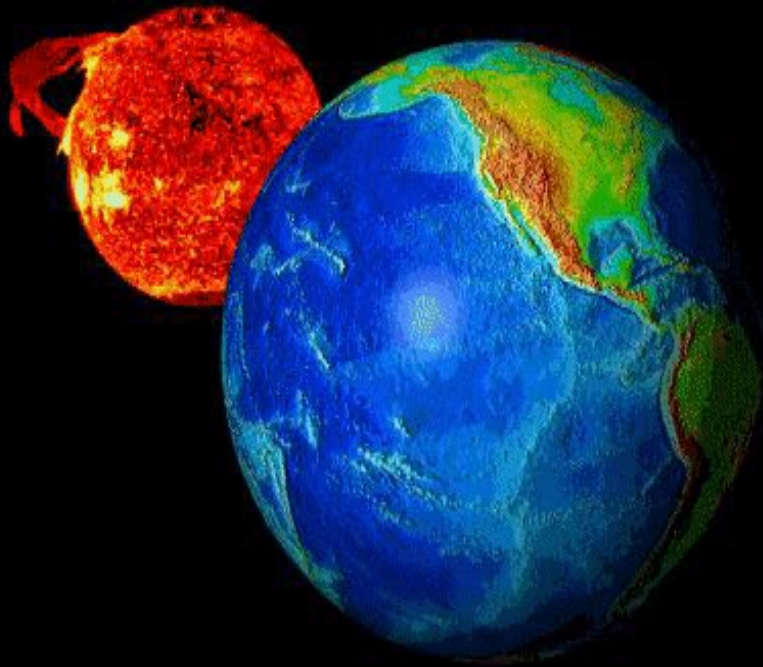
OVERVIEW



- **What is Space Weather ?**
- **Solar Features**
- **Solar Events**



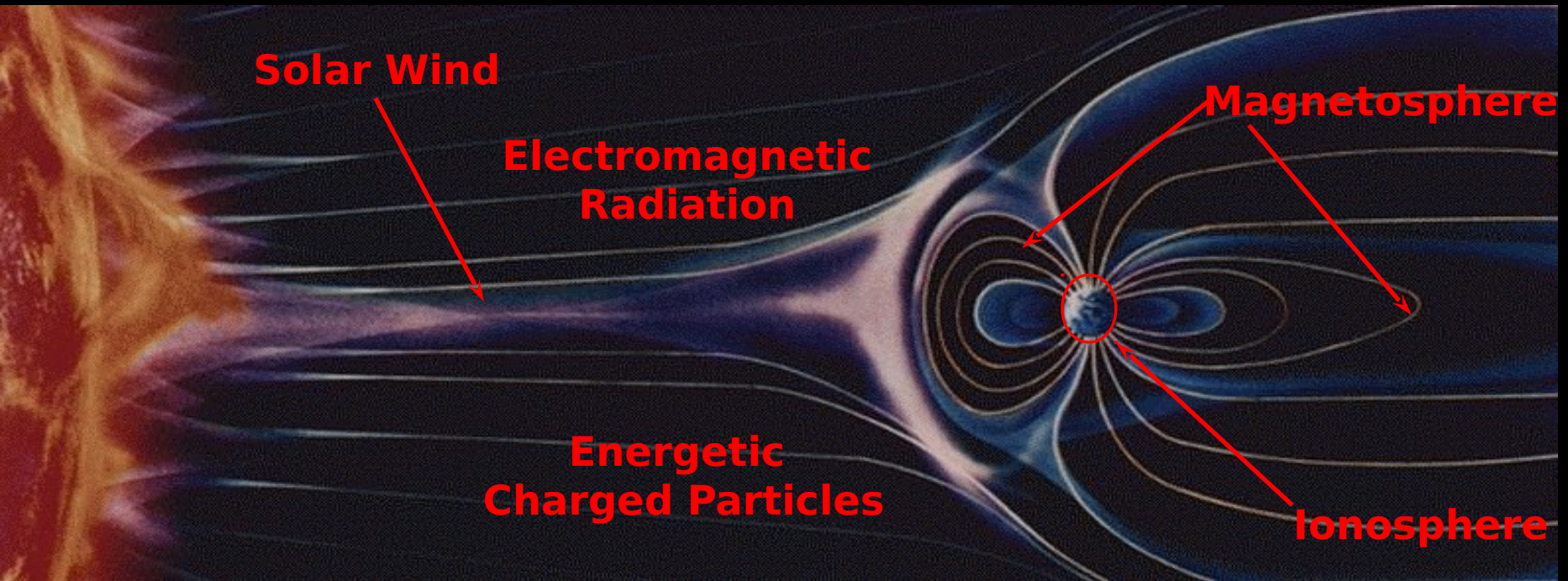
What is Space Weather?



Space weather describes the conditions in space that affect Earth and its technological systems. Space Weather is a consequence of the behavior of the sun, the nature of Earth's magnetic field and atmosphere, and our location in the solar system.

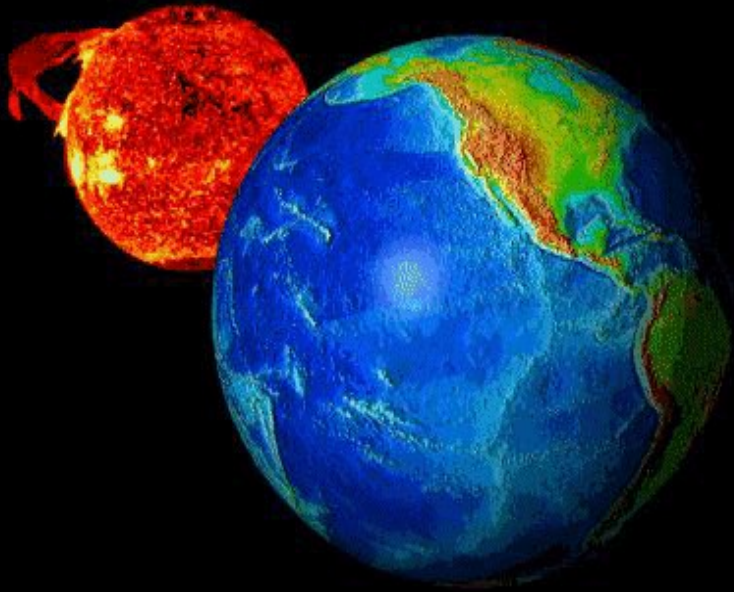


What is Space Weather?



- The Earth is surrounded by its own magnetic field (Magnetosphere) and upper atmosphere (Ionosphere)
- Solar electromagnetic radiation and energetic particles impact the Earth's Magnetosphere and Ionosphere, causing space weather disturbances which may degrade military systems

OVERVIEW



- What is Space Weather ?
- **Solar Features**
- Solar Events



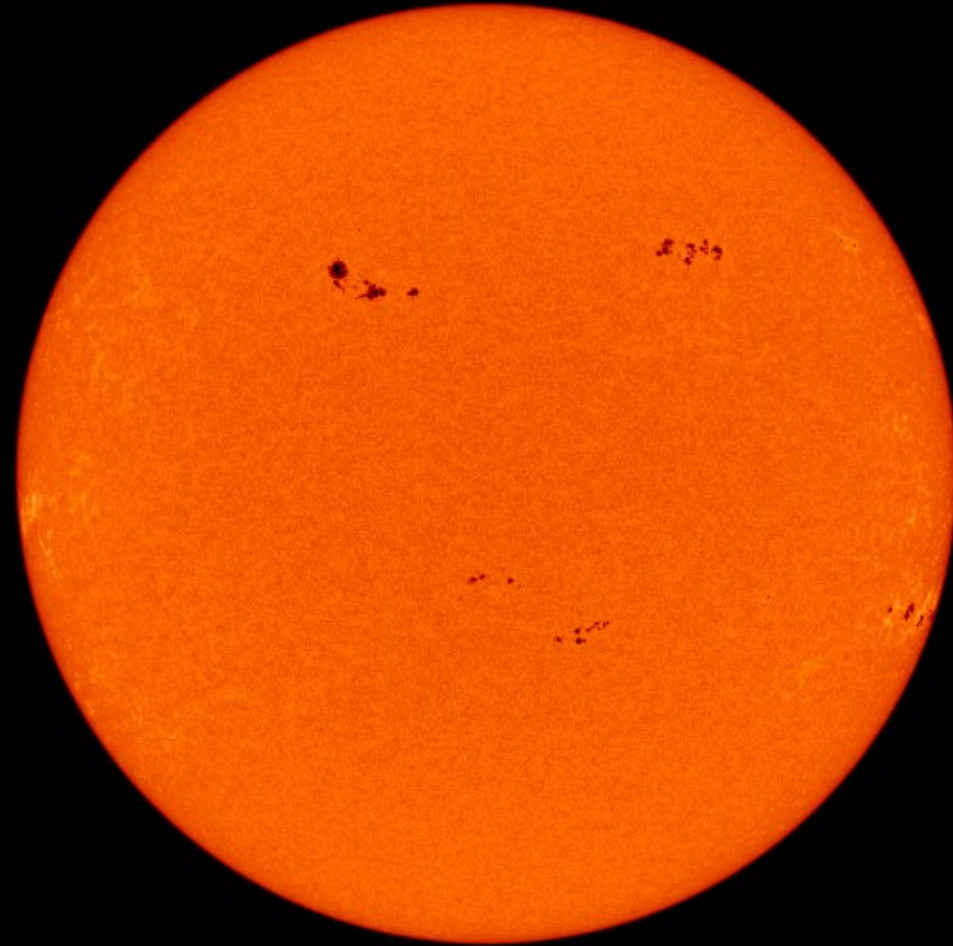
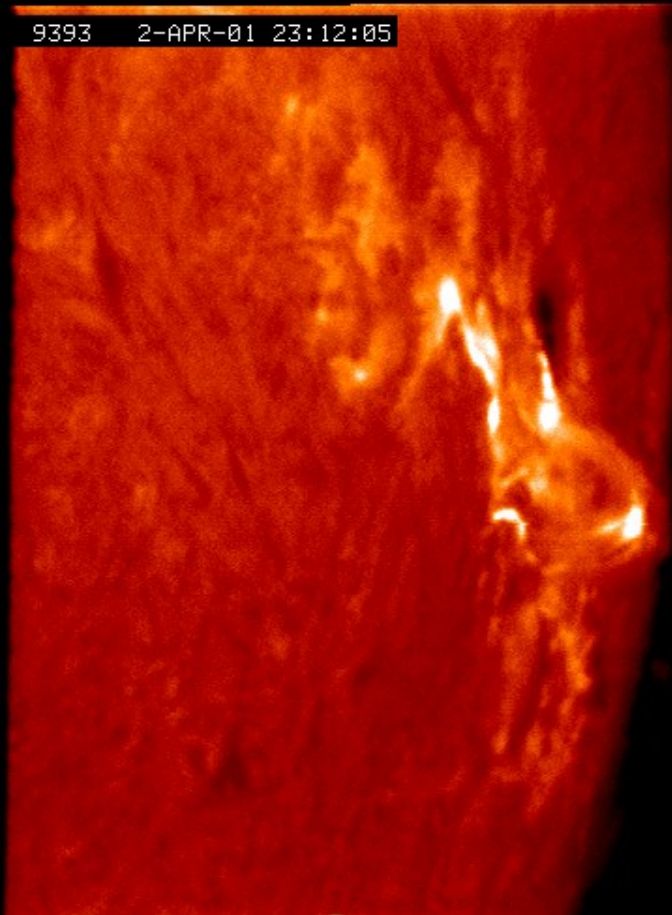
THE SPACE ENVIRONMENT

The Sun is the Primary Driver!





THE SUN



Our Star, the Sun

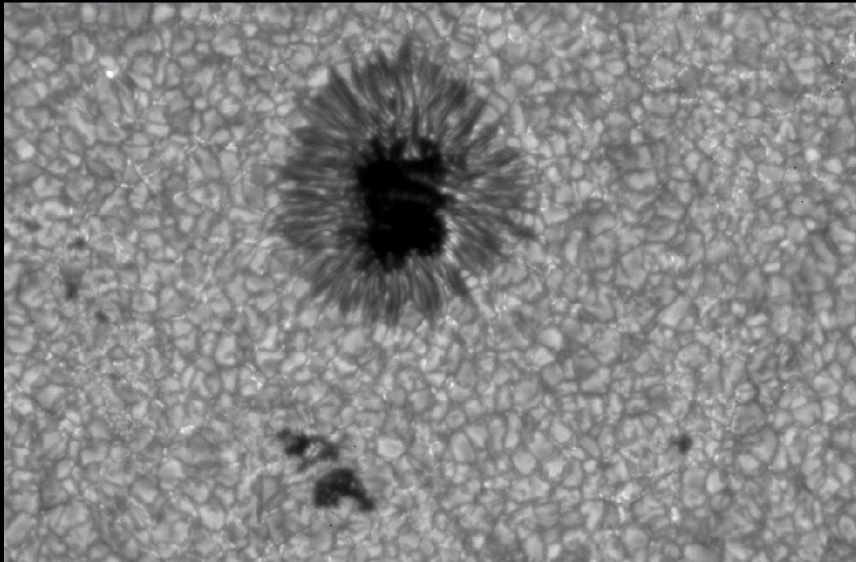
We all know that the Sun is overwhelmingly important to life on Earth, but few of us have been given a good description of our star and its variations.



SUNSPOTS

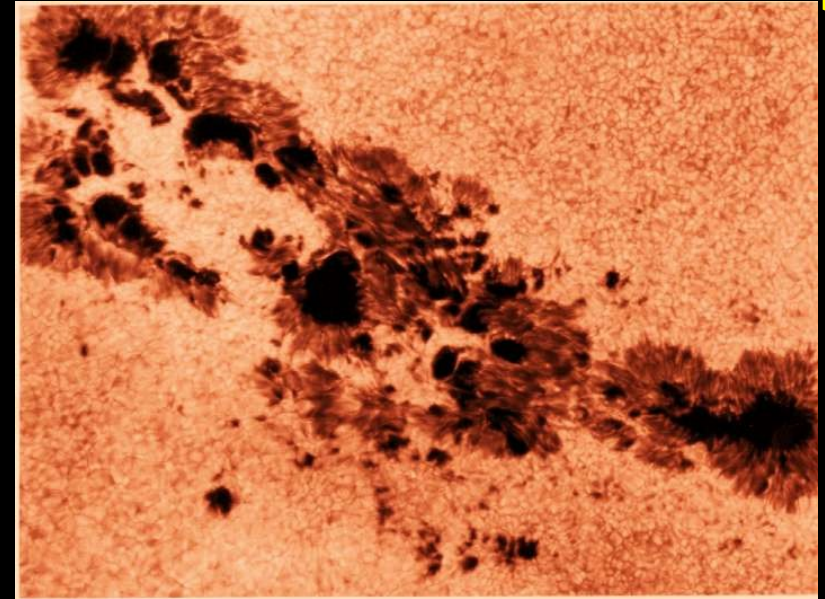
- **Sunspots are the most common indication of solar activity**

14 June 1994: G-Band



Source: Kiepenheuer/Uppsala/Lockheed (P. Brandt, G. Simon, G. Scharmer, E. Shine)

HAC A-003



- **Larger and more complex sunspot groups have greater potential for instability**



SUNSPOTS

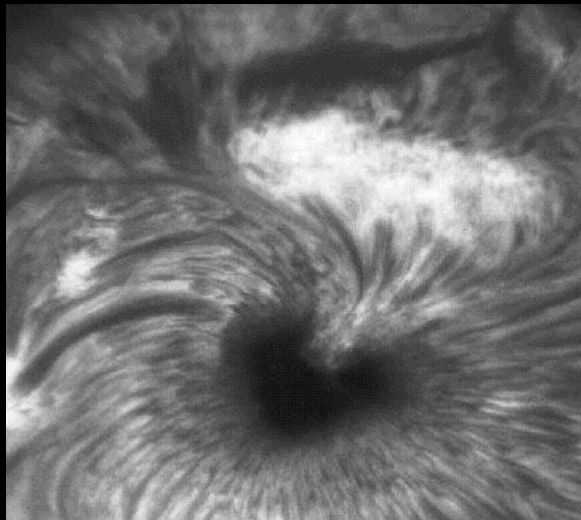


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PLAGE



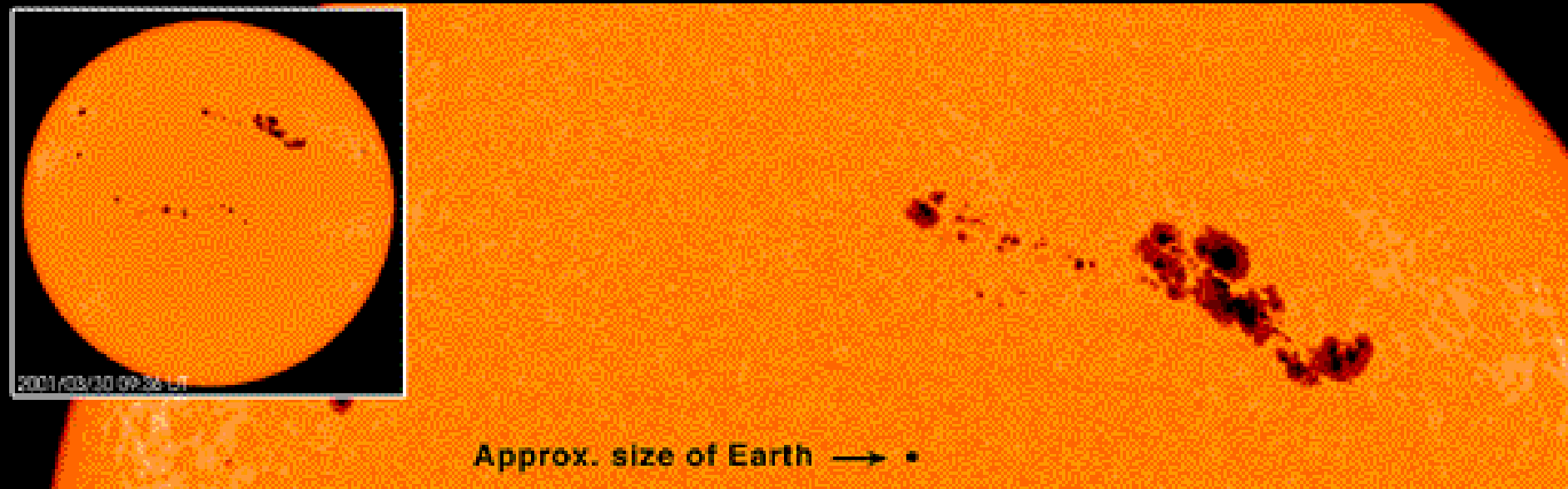
SUNSPOTS



Big Bear Solar Observatory
2000-06-13 15:26:07 UT



SUNSPOTS

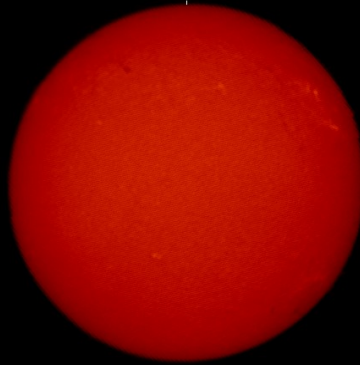


Huge sunspot group -- Active region 9393: the largest sunspot group observed during the current solar cycle. On 30 March 2001, the sunspots within the group spanned an area more than 13 times the surface area of the Earth! It was the source of numerous flares and coronal mass ejections, including the largest flare recorded in 25 years on 2 April 2001.

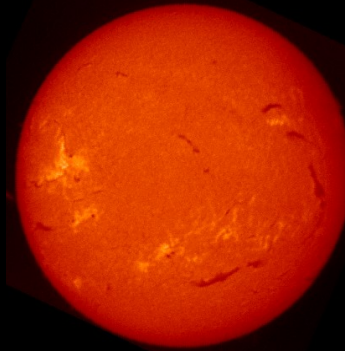


THE SOLAR CYCLE

**Solar
Minimum**

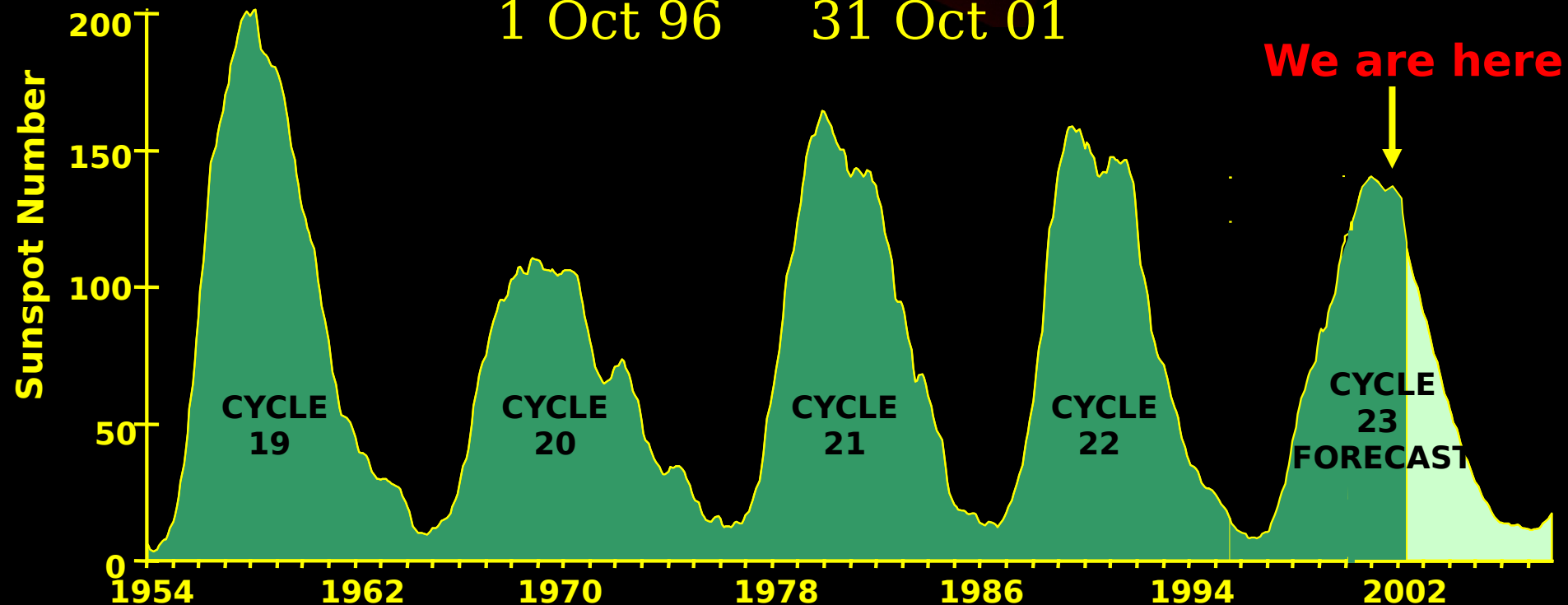


1 Oct 96



**Solar
Maximum**

31 Oct 01

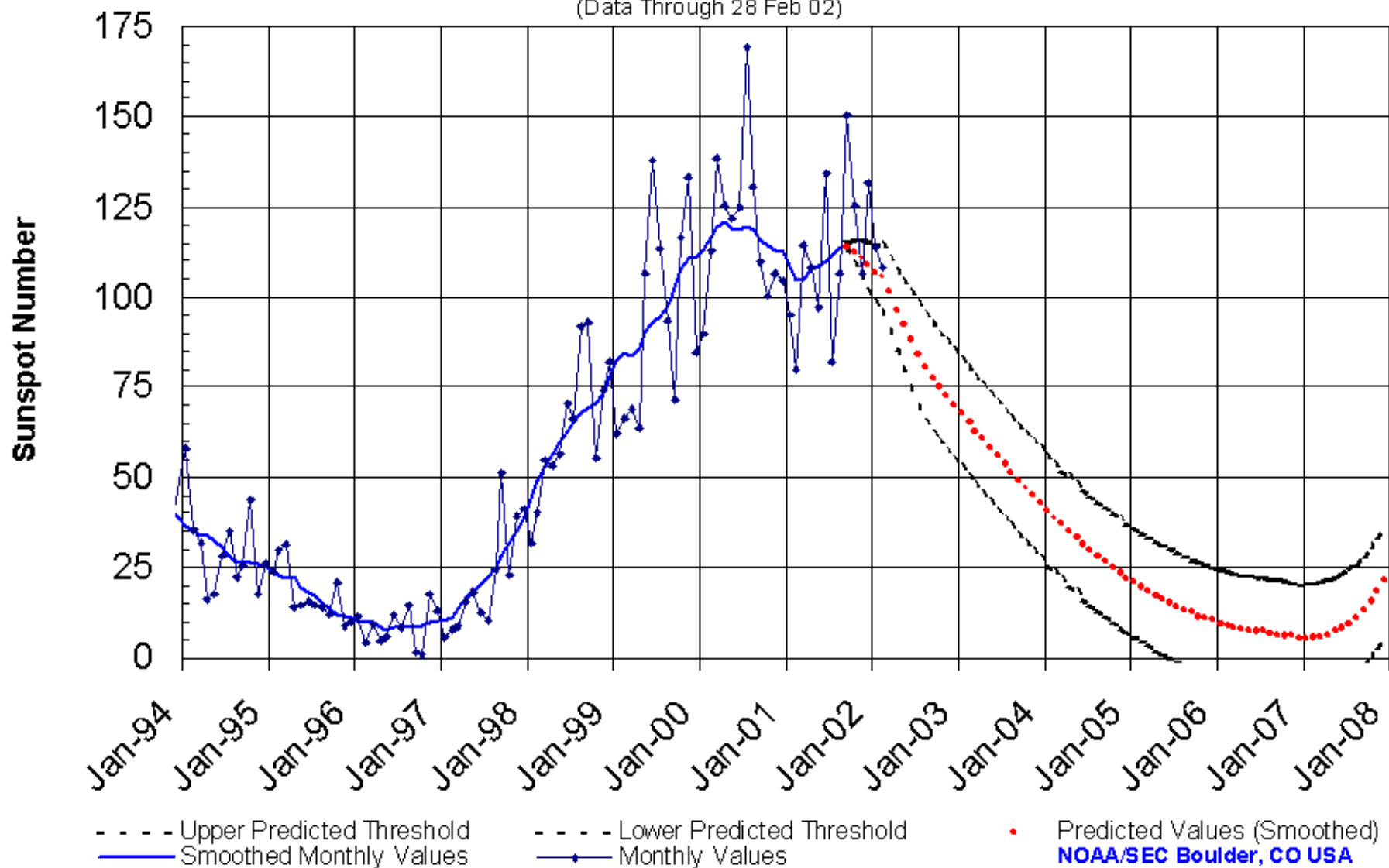




SOLAR CYCLE PROGRESSION

ISES Solar Cycle Sunspot Number Progression

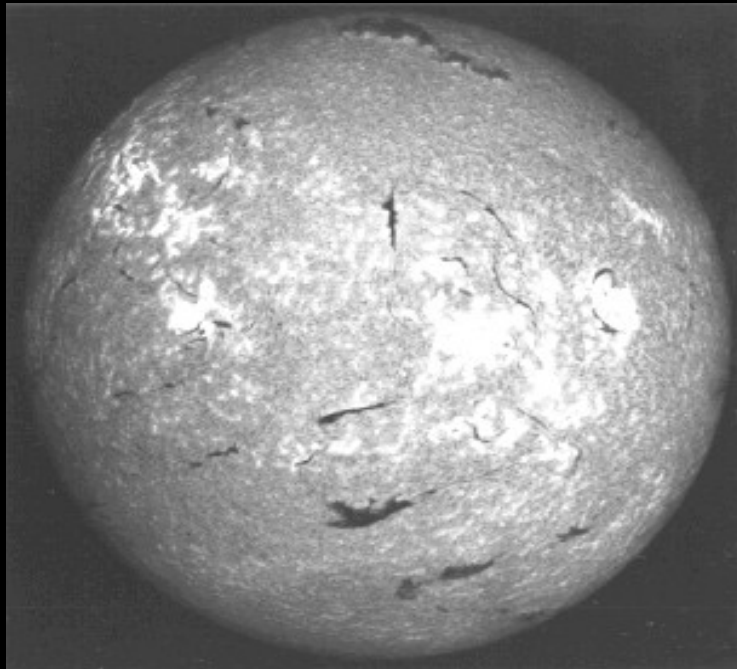
(Data Through 28 Feb 02)





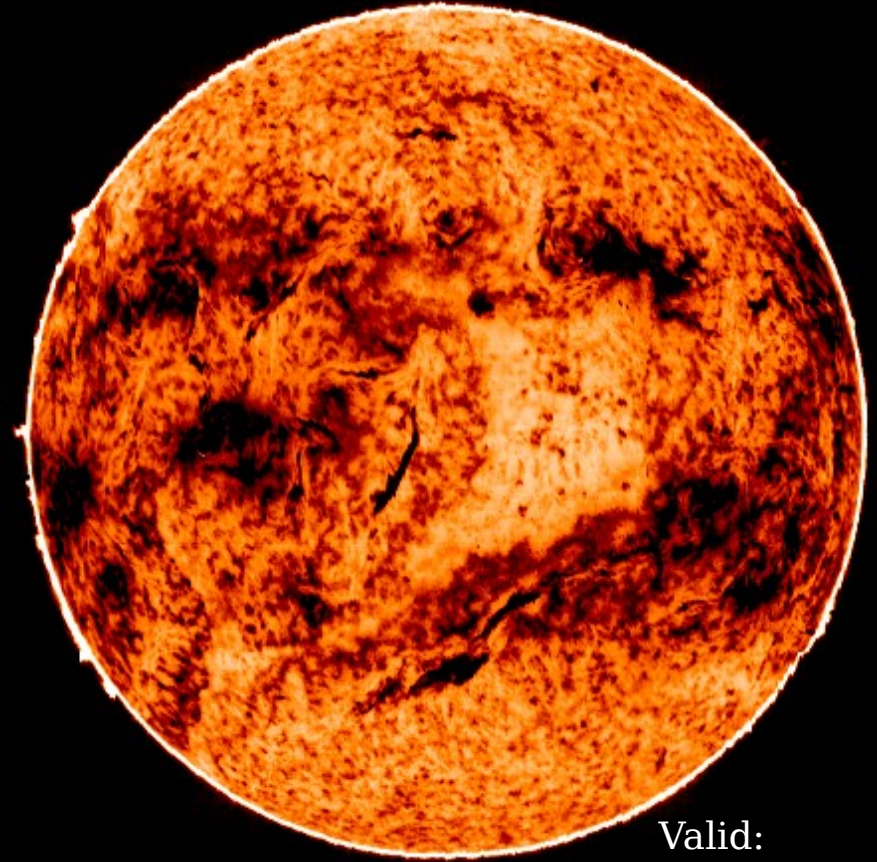
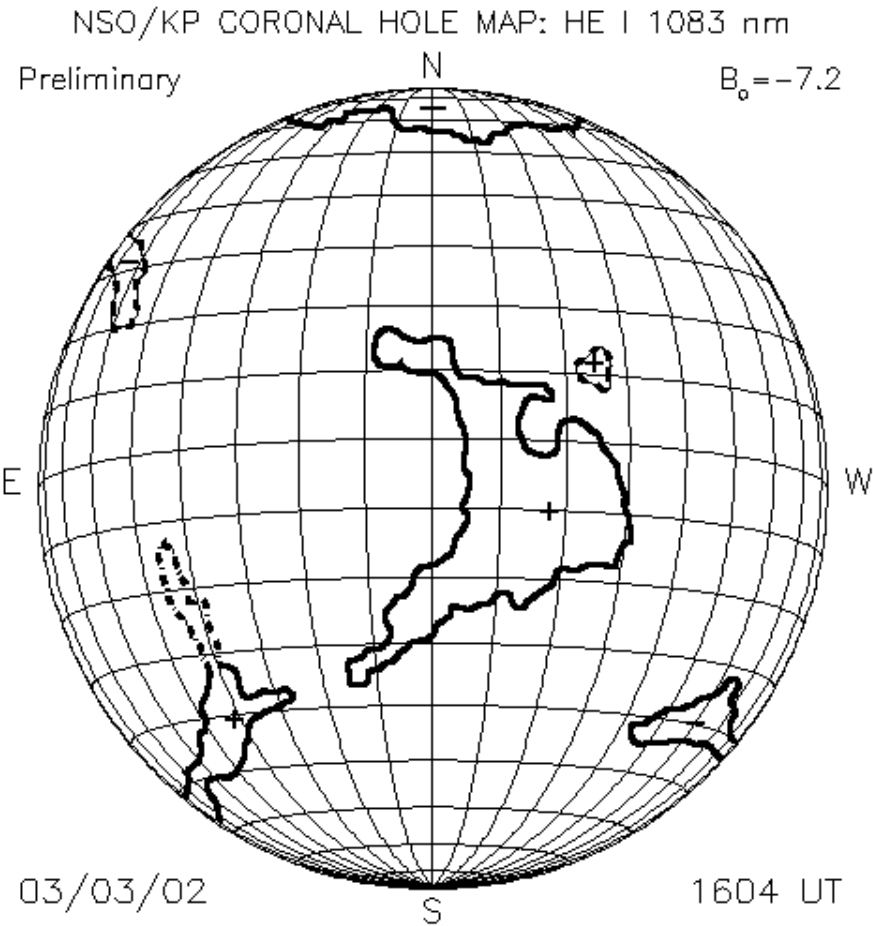
FILAMENTS & PROMINENCES

- **CLOUD-LIKE FEATURES IN THE SUN'S ATMOSPHERE**
- **CAN ERUPT AND THROW MATERIAL INTO SPACE**





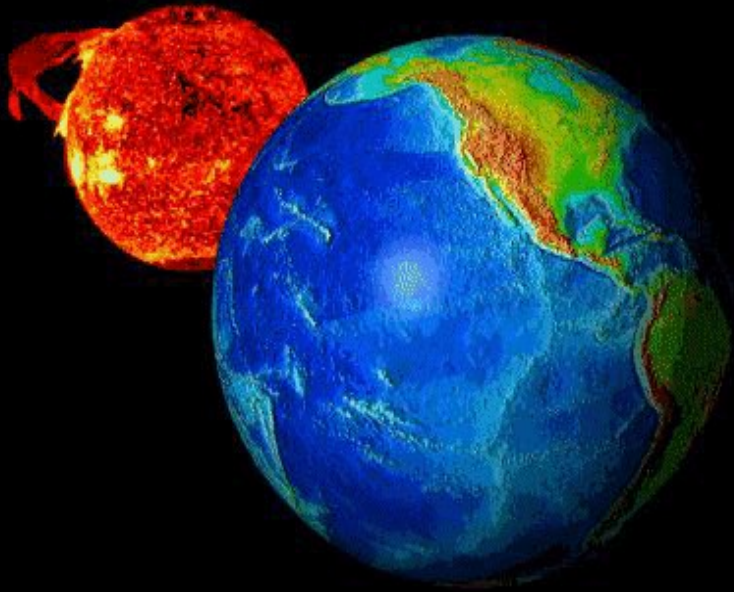
CORONAL HOLES



Valid:
03/1604Z

Coronal holes are variable solar features that can last for months to years. They are seen as large, dark holes when the Sun is viewed in x-ray wavelengths. These holes are rooted in large cells of uni-polar magnetic fields on the Sun's surface; their field lines extend far out into the solar

OVERVIEW

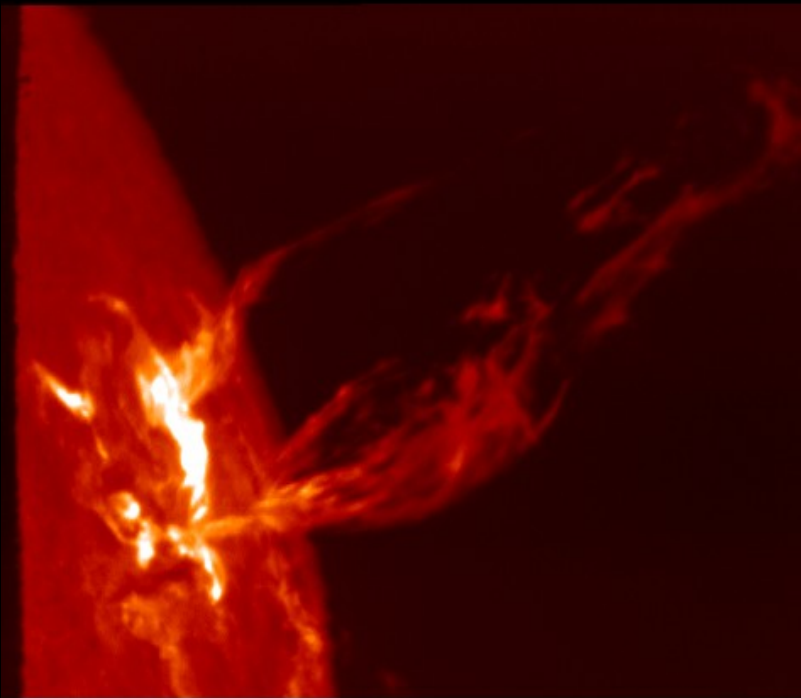


- What is Space Weather ?
- Solar Features
- **Solar Events**



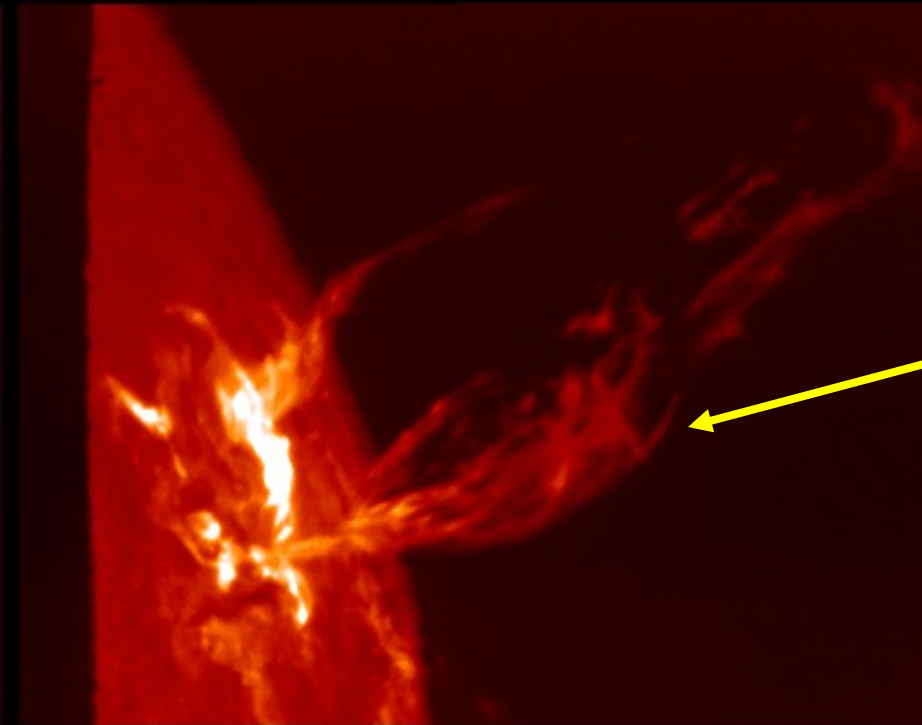
SOLAR FLARES

- **An explosive release of energy previously stored in intense, complex magnetic fields**





CME's

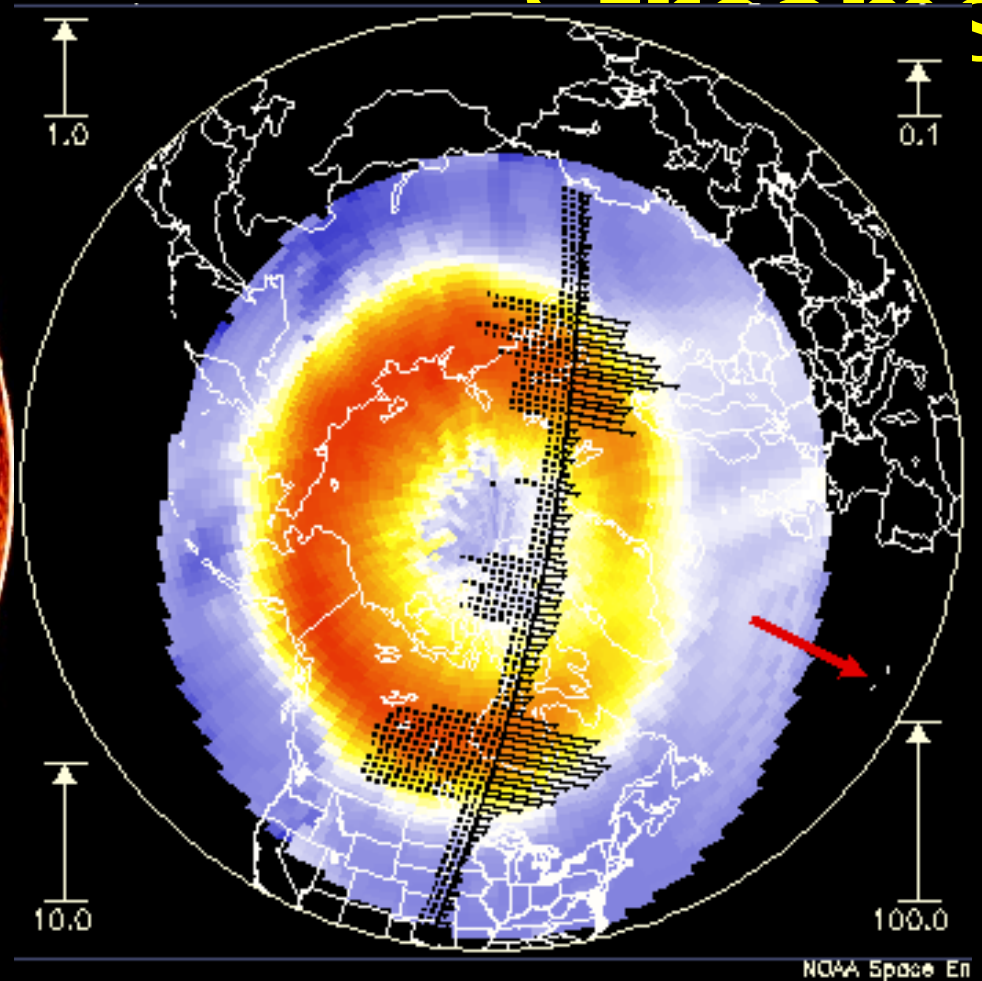
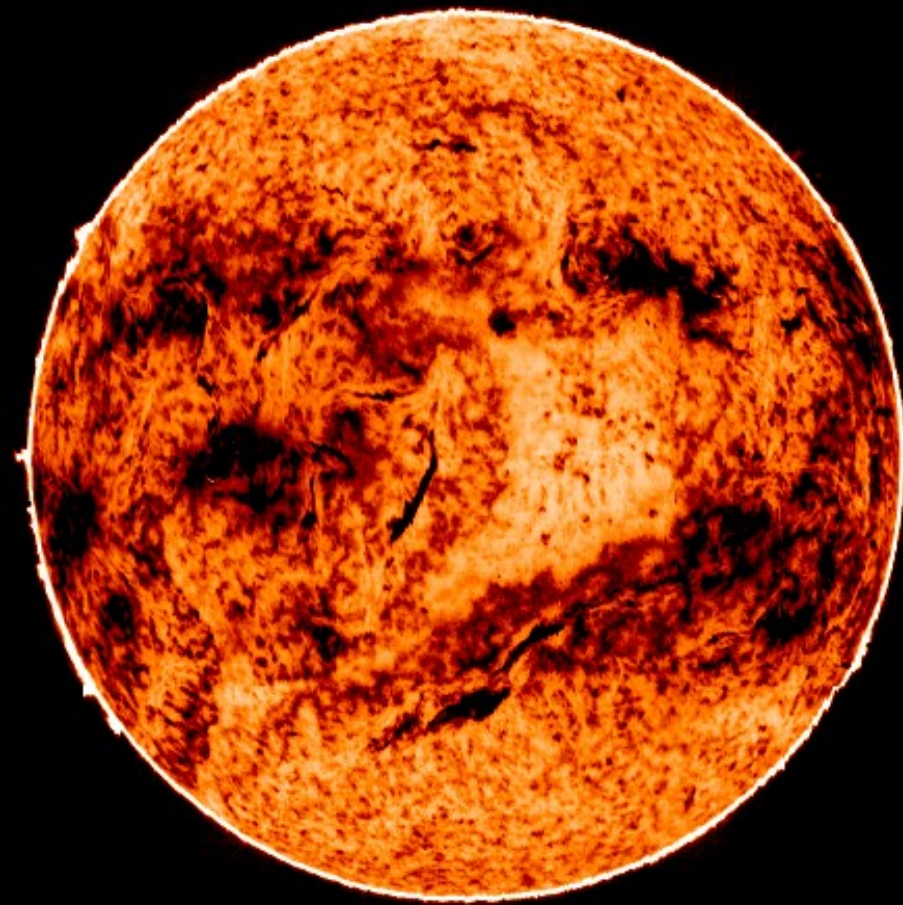


**Coronal
Mass
Ejection**

The outer solar atmosphere, the corona, is structured by strong magnetic fields. Where these fields are closed, often above sunspot groups, the confined solar atmosphere can suddenly and violently release bubbles or tongues of gas and magnetic fields called coronal mass ejections. A large CME can contain 10.0×10^{16} grams (a billion tons) of matter that can be accelerated to several million miles per hour in a spectacular explosion. Solar material streaks out through the interplanetary medium, impacting



High Speed Solar Wind



Coronal holes are the source of high-velocity solar wind, and often result in disturbances in the Earth's geomagnetic field.